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ABSTRACT

The National Science Foundation Division of Science Resources Studies (SRS) has a legislatively mandated responsibility for the collection, compilation, and analyses of information related to science and technology, inputs, outputs, and impact. This constitutes a broad charter requiring diverse activities. The products of these activities are of utility to a heterogeneous clientele, varying from governmental science and technology policymakers to institutional managers and research analysts. This compilation of project summaries has been prepared to provide various SRS users with a rapid overview of all current and recently completed SRS projects. All projects were either ongoing or completed during fiscal year 1983. The summaries include information on objectives, findings, methodology, authorship, and resulting publications and availability. Projects are organized in the following groups: (1) overview projects; (2) human resources (scientists, engineers, technicians), subdivided according to characteristics, education, employment, and projections; (3) funding of science and technology, subdivided according to government, industry, and universities, colleges, and other nonprofit organizations; (4) outputs and impacts, subdivided according to innovations and inventions, bibliometrics, economic implications, and other areas. Lists of principal investigators, and intramural (SRS) and extramural publications are provided in appendices. (JN)

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foreword

The Division of Science Resources Studies (SRS) engages in numerous activities to produce information and analyses pertinent to a fuller understanding of the magnitude, characteristics, and dynamics of the technical resources of the United States. Projects that produce this information either are staffed intramurally or consist of extramural activities supported through grants and contracts. The information generated is intended to be of interest to policymakers in all sectors of the national science and technology enterprise as well as to those who analyze the operation of this technical system. A need has been expressed for a compact reference volume that permits a rapid overview of all of the projects carried out by the Division and that provides a summary of each endeavor. This publication responds to such a need and is the third volume of an annual series. It presents an overview of the many facets that are being illuminated by SRS efforts. It also furnishes sufficient information on project objectives, methods, results, and references to facilitate user selection of projects for further investigation. Any constructive criticism or comment from the user community by which the format of this publication might be improved would be greatly appreciated.

Charles E. Falk, Director
Division of Science Resources Studies
Directorate for Scientific, Technological, and International Affairs

September 1983

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notes

The Division of Science Resources Studies (SRS) of the National Science Foundation (NSF) has a legislatively mandated responsibility to collect, compile, and analyze information related to science and technology resources and the outputs and impacts of those resources. Such a broad charter requires numerous activities, the products of which are used by a diverse clientele, varying from governmental science and technology policymakers to institutional managers and research analysts. The clientele are interested not only in the actual results of the various surveys and studies, but also in the nature of projects that are still ongoing. This compilation of summaries provides these various users with a rapid overview of all currently ongoing and recently completed SRS projects. Summary publications are issued on an annual basis.

All projects summarized in this publication were either ongoing or completed during FY 1983 (October 1, 1982 through September 30, 1983). The summaries include information on objectives, findings, methodology, authorship, and resulting publications. Projects for which "NA" is given under "Major Findings" and "Availability" are those that are ongoing and for which findings and resulting publications are not yet available. The summaries are organized in major substantive groups. Projects noted as being intramural are those carried out directly by the staff of the Division and may include information developed under SRS sponsorship by other Government agencies and by contractors. Extramural projects are those for which institution(s) and/or principal investigators are identified, and are supported through NSF grants and contracts. Appendix A is an alphabetical listing of all principal investigators so identified in the project summaries.

Publications are identified in the three formats used by SRS: *Highlights*, Detailed Statistical Tables, and Reports. A *Science Resources Studies Highlights* is normally restricted to four pages and presents the essence of the analyzed data in brief statements and in graphic and tabular form. As soon as feasible after the *Highlights* has been issued, survey data are released as Detailed Statistical Tables for the reference and convenience of other analysts and researchers. A more complete analysis is then developed and published in a Final Report. When the subject is one of an ad hoc nature, the publication is identified as a Special Report. The SRS Editorial and Inquiries Unit (EIU) maintains a mailing list by which users of SRS publications automatically receive copies of *Highlights*, Detailed Statistical Tables, and Reports. A listing of all SRS publications issued since January 1, 1973, is included as appendixes B and C of this publication.

Written or telephone inquiries concerning the nature and availability of data may be made to any of the following appropriate offices of the Division of Science Resources Studies, 1800 G Street, N.W., Washington, D.C. 20550:

R&D Economic Studies Section, Rm. L602	202-634-4625
Government Studies Group, Rm. L602	202-634-4636
Industry Studies Group, Rm. L602	202-634-4648
Universities, Colleges, and Nonprofit Institutions Studies Group, Rm. L602	202-634-4629
Scientific and Technical Personnel Studies Section, Rm. L611	202-634-4691
Demographic Studies Group, Rm. L611	202-634-4664
Supply and Education Analysis Group, Rm. L611	202-634-4787
Utilization Studies Group, Rm. L611	202-634-4655
Science Indicators Unit, Rm. L611	202-634-4682

Written or telephone inquiries concerning the availability of SRS publications may be directed to EIU, Room L611, 202-634-4622 or 202-634-4623.

section I. overviews

PROJECT:
Academic Science, 1972-83

Objective:

To provide consolidated biennial analyses of academic research and development (R&D) expenditures, the utilization of academic scientists and engineers, and the characteristics of the graduate science/engineering (S/E) student population.

Method:

The report presents analyses based on data selected primarily from the following three academic surveys: (1) Scientific and Engineering Expenditures at Universities and Colleges, FY 1972 through FY 1981; (2) Scientific and Engineering Personnel Employed at Universities and Colleges, January 1973 through 1982; and (3) Graduate Science Student Support and Postdoctorates, Fall 1975 through Fall 1981.

Major Findings:

One out of every ten R&D dollars was spent by universities and colleges in 1981 and one-half of the $9 billion devoted to basic research was performed in the academic sector. Between 1972 and 1981 R&D expenditures by universities grew at an average rate of 3% per year in real-dollar terms, and academic employment of scientists and engineers rose at about the same rate. The number of full-time science and engineering (S/E) professionals rose 23% in nine years, but part-timers increased by nearly 70%. R&D involvement of S/E employees rose 28% between 1973 and 1982, accompanied by a similar growth in the number of S/E employees involved in teaching and other activities. Graduate S/E enrollment in doctorate-granting institutions rose 16% from fall 1975-81, with part-time enrollment going up faster than full-time—27% compared to 12%.

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

It is anticipated that the final report will be published by spring 1984 and will be available from SRS/Editorial and Inquiries Unit.

PROJECT:
Science and Engineering (S/E) Personnel, 1982

Objective:

To provide a comprehensive overview of current employment, supply patterns, and the dynamics of the labor market for all U.S. scientists and engineers.

Method:

Based on data from a coordinated set of SRS surveys and other primary and secondary data sources. Report generally is descriptive, with some analytical treatment of data.

Major Findings:

Job opportunities for scientists and engineers in the United States continued to expand between 1978 and 1980 as employment in S/E jobs increased by 7% to 2.6 million. Fueled by rapid growth among computer specialists and life scientists, employment of scientists in S/E activities grew more rapidly than the comparable employment of engineers between 1978 and 1980 (10% versus 3%). Between 1978 and 1980, employment of women rose more than 5 times faster than employment of men (32% versus 6%). Despite this dramatic growth, women represented about 13% of the S/E work force in 1980, compared to about 40% of all professional and related workers. Employment of members of minority groups who are scientists or engineers grew more rapidly than employment of whites between 1978 and 1980 (17% for blacks, 11% for Asians, and 7% for whites).

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section

Institution/Principal Investigator:

[Intramural]

Availability:

Science and Engineering Personnel: A National Overview, NSF 82-318, October 1982, Supt. of Documents, U.S. Government Printing Office, Washington, D.C. 20402, Stock Number 038-000-00518-9, $5.50; National Technical Information Service, Springfield, Virginia 22161, PB 81-188654, $9.00 (paper copy), $4.00 (microfiche); also available from SRS/Editorial and Inquiries Unit.

PROJECT:
Science and Technology Resources, 1983

Objective:

To present an overview of U.S. science and technology resources based on the most current information available to the Foundation.

Method:

Information originated from a series of systematic, regularly recurring surveys of institutions and individual scientists and engineers. The data include research and development (R&D) funding by source of funds and performer, character of work (basic research, applied research, and development), national objectives, and international comparisons. Topics concerning science and engineering (S/E) personnel include women and minorities, employment trends, S/E labor market balance, and the sources of new S/E personnel.

Major Findings:

R&D expenditures in the United States totaled $86.5 billion in 1983, an increase of 9% over the previous year (4% in constant dollars). For 1982, the overall increase in the Nation's R&D expenditures was an estimated 10% (3% in constant dollars).

S/E employment between 1976 and 1981 increased at an annual average of 6%, in contrast with the 3% rate for the total work force. The S/E unemployment rate increased to less than 3% in 1982, but was still substantially below the 9% rate for all workers.

Responsible SRS Organizations:

R&D Economic Studies and Scientific and Technical Personnel Studies Sections

Institution/Principal Investigator:

[Intramural]

Availability:

"National R&D Expenditures Expected to Reach $85 Billion in 1983," *Highlights*, NSF 82-311, June 11, 1982, available from SRS/Editorial and Inquiries Unit. Additional data for 1983 will be incorporated in *National Patterns of Science and Technology Resources: 1984*, Report, and available in spring 1984 from SRS/Editorial and Inquiries Unit.

PROJECT:
Science and Technology Resources, 1984

Objective:

To present an overview of U.S. science and technology resources based on the most current information available to the Foundation.

Method:

Information originated from a series of systematic, regularly recurring surveys of institutions. The data were then aggregated by the four major sectors of the economy and included research and development (R&D) funding by sources of funds and performer, character of work (basic research, applied research, and development), and international comparisons.

Major Findings:

R&D expenditures in the United States is expected to total an estimated $97.0 billion in 1984, an increase of 12% over the previous year (7% in constant dollars). For 1983, the overall increase in the Nation's R&D expenditures is estimated at 9% (4% in constant dollars).

Responsible SRS Organization:

R&D Economic Studies Section

Institution/Principal Investigator:

[Intramural]

Availability:

"Defense and Economy Major Factors in 7% Real Growth in National R&D Expenditures in 1984," *Highlights*, NSF 83-316, July 22, 1983, available from SRS/Editorial and Inquiries Unit.

PROJECT:
Science Indicators—1982

Objective:

To present quantitative indicators of the state of science and technology in the United States, supplementing but not supplanting the judgment of policymakers who are faced with specific science and technology issues.

Method:

The report draft was prepared in the SRS/Science Indicators Unit for review by a special committee of National Science Board members. Chapters were reviewed by technical experts, and by research and development (R&D) executives of other Federal agencies, and then issued by the full National Science Board.

Major Findings:

Science Indictors—1982 is the sixth in a series of similar reports by the National Science Board. It presents statistical

indicators with relevant interpretation and explanation. It is organized int › seven chapters:

1. International Science and Technology
2. Support for U.S. Research and Development
3. Science and Engineering Personnel
4. Industrial Science and Technology
5. Academic Science and Engineering
6. Public Attitudes Toward Science and Technology
7. Advances in Science and Engineering

This report contains one chapter (number 5) that was not part of the previous *Science Indicators* reports.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

[Intramural]

Availability:

Science Indicators--1982, will be available in early 1984 at the Supt. of Documents, U.S. Government Printing Office, Washington, D.C. 20402, and from the Publications Office, Room 235, National Science Foundation, 1800 G Street, N.W., Washington, D.C. 20550.

PROJECT:
U.S. Scientists and Engineers, 1982

Objective:

To provide estimates of the U.S. population of scientists and engineers, as well as of their demographic, education, and employment characteristics.

Method:

The results of several surveys conducted by the NSF Scientific and Technical Personnel Characteristics System are being synthesized to produce estimates as of mid-1982.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/ Demographic Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

U.S. Scientists and Engineers: 1982, Detailed Statistical Tables, will be available from the SRS/Editorial and Inquiries Unit by spring 1984.

PROJECT:
Women and Minorities in Science and Engineering

Objective:

To present a factual picture of the current situation and recent trends in the participation of women and minority group members in science and engineering (S/E) employment and training. The report, the second in a biennial series, is required under Public Law 96-516.

Method:

Based on data from SRS surveys and other primary and secondary data sources. Report is primarily factual, with some analytical treatment of the data.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section

Institution/Principal Investigator:

[Intramural]

Availability:

NA

section II. human resources

a. characteristics

PROJECT:
Comparisons of Tasks and Earnings of Scientists and Engineers

Objective:

To improve the methods used in analyzing the gender-related salary differences for workers, and to test the hypothesis that the lack of growth of job opportunities for elementary- and secondary-school teachers—traditional jobs for college-educated women—has influenced the flow toward science and engineering.

Method:

The study will examine the entrants to the labor market during the 1970's using survey data collected for NSF. It will compare the earnings of women with those of their male counterparts by age, employment, and education, identifying the reasons women opt to enter these fields, and examine the differences in job activities of women and men working as scientists and engineers.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

Center for Naval Analysis

Availability:

Results are expected in the spring of 1984.

PROJECT:
A Comparative Study of S/E Personnel in Selected Highly Industrialized Countries

Objective:

To assemble collected data by which scientific and technical personnel in the United States can be compared with those of the United Kingdom, France, West Germany, and Japan and to examine the significance revealed by these comparative data for high technology and critical industries.

Method:

The Principal Investigator and other staff members are visiting the selected countries and contacting representatives of industry, educational institutions, and governments in order to identify existing and future sources of data on scientific and technical personnel. Analytical comparisons will be made to establish the significance of the differences revealed by these data.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

Horizon Institute for Advanced Design/Joseph Mintzes

Availability:

Data and report are expected in January 1984 for the United Kingdom, France, and West Germany. Data and report for Japan are expected by early 1985.

PROJECT:
Comparative Trends in Academic Abilities of Doctorates in Science, Engineering, and Other Professions

Objective:

To determine if persons of high academic ability and potentially high productivity are choosing careers in professions at the expense of the sciences or engineering.

Method:

Scholastic Aptitude and American College Testing scores of persons who received science and engineering doctorates during the past 15 years will be compared to those for persons receiving doctorates in the humanities, or degrees in business, law, and medicine. The 15-year time frame of the study will allow for the analysis of data reflecting a variety of labor market conditions for new doctorates.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

Educational Testing Service/Rodney T. Hartnett

Availability:

Expected to be published in spring 1984 and to be available from SRS/Editorial and Inquiries Unit.

PROJECT:
The Doctorate Survey

Objective:

To collect information on characteristics and work plans of new science and engineering (S/E) doctorates through the Survey of Earned Doctorates and to maintain the computerized Doctorate Records File, which is virtually a complete listing of the more than 700,000 students who have received their doctorates since 1920.

Method:

Questionnaires are distributed to all individuals receiving doctorates, and are completed by them near the time of graduation. In recent years, response rates have been better than 95%. Nonrespondents to the questionnaires are represented in the data base through information obtained from public records such as official commencement programs. Information is collected on demographic characteristics, educational history, sources of financial support for graduate study, and plans for postdoctoral study or employment.

Major Findings:

About 17,600 S/E doctorates were produced in 1982, the same as in 1981. The 1982 figure was approximately 7% below the peak reached in 1973. These 1982 S/E doctorates represented 57% of total 1982 doctorate production, the highest level since 1972. Engineering doctorate production increased for the second successive year from 2,530 in 1981 to 2,640 in 1982, but was still well below the 1972 peak of 3,500. The share of engineering doctoral degrees awarded to U.S. citizens continued to decline from 67% in 1972 to 47% in 1982. The trend in science doctorate production has been downward since 1972. In three fields, however, degree production rose: Psychology (38%) and the life and earth sciences (9% each). The number of women S/E doctorates almost doubled between 1972 and 1982. Women received 23% of total S/E degrees earned in 1982.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Supply and Education Analysis Group

Institution/Principal Investigator:

National Academy of Sciences/Peter D. Syverson

Availability:

A *Highlights* and Detailed Statistical Tables will become available from SRS/Editorial and Inquiries Unit in fall 1983. *Summary Report, 1982. Doctorate Recipients From United States Universities* is available from the Commission on Human Resources, National Research Council, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C. 20418 and will be available from the National Technical Information Service, Springfield, Virginia 22161.

PROJECT:
New Entrants to Science and Engineering, 1982

Objective:

To obtain the professional, employment, and education characteristics of recipients of bachelor's and master's degrees in science and engineering in the classes of 1979/80 and 1980/81.

Method:

A two-stage sampling plan was utilized to identify a sample (22,000) of science and engineering (S/E) bachelor's and master's recipients. The first stage sampled the universe of those institutions of higher education that grant S/E degrees. The second stage sampled the graduates of the institutions selected in the first stage. The selected individual graduates received a mail questionnaire during the summer and fall 1982. The data collection focused on education, employment, and professional characteristics.

Major Findings:

The 1980 S/E graduates experienced greater difficulty in locating employment in 1982 than had the 1978 S/E graduates in 1980. Two years following their graduation, the classes of 1978 and 1980 reported 3.1% and 5.5% unemployment rates, respectively. Some graduates were in demand, particularly those in the computer specialist, engineering, and economic fields, for whom the unemployment rate was reported as being less than 2.0%. The demand for computer specialists continued to exceed the supply of graduates in that field for jobs in S/E-related work. Only about two-fifths of the 1980 S/E graduates employed as computer specialists in S/E-related work had received their degrees in computer science. Another two-fifths of those so employed had received their baccalaureates in mathematics/statistics.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

Temple University/Koray Tanfer

Availability:

Characteristics of Recent Science/Engineering Graduates: 1980, Detailed Statistical Tables, NSF 82-313, October 1982; available from National Technical Information Service, Springfield, Virginia 22161, PB 82-262478, $10.50 (paper copy), $4.00 (microfiche); also available from SRS/Editorial and Inquiries Unit.

PROJECT:
1982 Postcensal Data on Scientists and Engineers

Objective:

To obtain the professional, employment, and education characteristics of individuals in selected occupations included in the 1980 Decennial Census.

Method:

A sample of individuals (150,000) was drawn from the 1980 Census of Population and Housing for selected occupations. This sample was stratified in terms of sex and race. The members of the sample received a mail questionnaire in the spring of 1982. The data collection focused on education, employment, and professional characteristics of respondents.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

Bureau of the Census/Bruce Chapman

Availability:

Characteristics of the Scientists and Engineers in the 1982 Postcensal Survey is expected to be available in early 1984 from SRS/Editorial and Inquiries Unit.

PROJECT:
Survey of Doctorate Recipients

Objective:

To obtain the professional, employment, and education characteristics of the Nation's science and engineering (S/E) doctorate population.

Method:

A sample (50,000) of S/E doctorate holders who received their degrees during the period 1940-82 was drawn from the Doctorate Roster. The resulting individuals received a mail questionnaire during the spring of 1983. The information-collection phase will terminate at the end of the calendar year.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

National Academy of Sciences/Betty D. Maxfield

Availability:

A *Highlights* is expected to be available by August 1984 from SRS/Editorial and Inquiries Unit. *Characteristics of Doctoral Scientists and Engineers in the United States: 1983*, Detailed Statistical Tables; publication is expected by early 1985, and will be available from SRS/Editorial and Inquiries Unit.

section II. human resources

b. education

PROJECT:
Graduate Science and Engineering (S/E) Enrollment, 1981

Objective:

To provide quantitative information by discipline on the characteristics of graduate S/E students and postdoctorates, with emphasis on their sources of support.

Method:

All graduate S/E departments in 302 master's- and 324 doctorate-granting institutions received the annual questionnaire for fall 1981 data. There were several elements: Major sources and types of full-time graduate students' suppport, graduate enrollment status (full- or part-time), level of study, citizenship, sex, and racial/ethnic origin. Data were also collected on support patterns of postdoctorates and on nonfaculty doctoral research staff. Responses were received from 89% of the institutions surveyed. The survey was closed out in September 1982.

Major Findings:

S/E graduate enrollment continued to increase but at a slightly lower rate than the 3% average growth since 1975, exceeding 392,000 in 1981. The greatest enrollment surge was reported in the computer sciences, growing by 21%, but engineering enrollment grew at a much faster rate than science enrollment as a whole (8% contrasted with 2%). In doctorate-granting institutions, 22% of the 1980 total full-time S/E graduate students were foreign and 33% were women.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Graduate Science/Engineering Enrollment Rose 2% in 1981, Mostly in 'High-Tech' Fields," *Highlights*, NSF 83-310, April 25, 1983, available from SRS/Editorial and Inquiries Unit, and *Academic Science/Engineering: Graduate Enrollment and Support, Fall 1981*, Detailed Statistical Tables, NSF 83-305, June 1983, National Technical Information Service, Springfield, Virginia 22161, PB 83-226100, $22.00 (paper copy), $4.50 (microfiche); also available from SRS/Editorial and Inquiries Unit. Access to the public-use tapes and documentation for their use are described in the Addendum to the *Data User Guide*, February 1983, available from the RDESS/Universities and Nonprofit Institutions Studies Group.

PROJECT:
Graduate Science and Engineering (S/E) Enrollment, 1982

Objective:

To provide quantitative information by discipline on the characteristics of graduate S/E students and postdoctorates, with emphasis on their sources of support.

Method:

All graduate S/E departments in 294 master's- and 324 doctorate-granting institutions received the annual questionnaires for fall 1982 data. There were several data elements: Major sources and types of full-time graduate students' support, graduate enrollment status (full- or part-time), level of study, citizenship, sex, and racial/ethnic origin. Data were also collected on support patterns of postdoctorates and on nonfaculty doctoral research staff. An optional sheet requested data on faculty rank, new hires, and departures during the previous academic year. The survey was closed out in June 1983.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

It is anticipated that Detailed Statistical Tables will be published early in 1984 and will be available from SRS/Editorial and Inquiries Unit.

PROJECT:
Neuroscience Personnel and Training

Objective:

To collect information from higher education institutions on the organizational structure used for graduate neuroscience training in 1981-82, on the faculty, postdoctorates, graduate students, and related education factors. Research on the nervous system has grown rapidly over the past decade, but there is a serious lack of information about the current status of personnel and training in the interdisciplinary neuroscience field.

Method:

The survey was conducted by the Higher Education Panel of the American Council on Education. The Panel includes a stratified sample of universities and colleges. The survey was mailed in June 1982 to 188 doctorate-granting universities and independent medical schools. The response rate was 93%. Weighted estimates were developed to represent the population of institutions with graduate neuroscience programs.

Major Findings:

The field of neuroscience experienced rapid growth during the seventies, but recent evidence suggests that there has been a slowing of the growth trend. Partially because of the newness of the field, there are few formal departments of neuroscience in universities, and most neuroscientists are based in departments of anatomy, pharmacology, physiology, biochemistry, biology, and psychology. There were about 2,600 neuroscience graduate students in fall 1981, 5% more than in 1980. About 500 doctorates were awarded in neuroscience programs in 1980/81 and 1981/82. There were approximately 1,270 postdoctorates in the fall of 1982, about the same as in 1980 and 1981. The trend toward slower growth rates was also evident among neuroscience faculty. Their numbers had increased by 8% in fall 1981 from about 3,170 in fall 1980, but slower growth—about 1%—was projected for fall 1982.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Supply and Education Analysis Group

Institution/Principal Investigator:

American Council on Education/Frank J. Atelsek

Availability:

"Growth in Neuroscience May be Leveling Off," *Highlights*, NSF 83-314, July 20, 1983, available from SRS Editorial and Inquiries Unit. "Neuroscience Personnel and Training," *Higher Education Panel Report*, No. 57, available from the Higher Education Panel, American Council on Education, One Dupont Circle, N.W., Washington, D.C. 20036 and from the National Technical Information Service, Springfield, Virginia 22161, PB 83-242172, $10.00 (paper copy), $4.50 (microfiche).

PROJECT:
Plant Biology Training and Personnel

Objective:

To collect information from doctorate-granting institutions about their programs for training graduate students in plant biology. Data will be requested about the numbers and characteristics of full-time graduate students, doctorate recipients, postdoctoral fellows, associates, and full-time faculty. Information will also be requested about the areas of concentration in graduate education and research, sources of support for research and for graduate and postdoctoral study, unfilled faculty postions, and the current employment market. The field of plant biology is undergoing rapid change, but there is a serious lack of comprehensive information about the current status of personnel and graduate training in this field.

Method:

The survey is being conducted by the Higher Education Panel of the American Council on Education. The Panel includes a stratified sample of universities and colleges. The survey is expected to be mailed in September 1983 to about 250 doctorate-granting institutions.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Supply and Education Analysis Group

Institution/Principal Investigator:

American Council on Education/Frank J. Atelsek

Availability:

The survey report is expected to be available in spring 1984 from the Higher Education Panel, American Council on Education, One Dupont Circle, N.W., Washington, D.C. 20036.

PROJECT:
Quality of Undergraduate and Graduate Students in Selected Science and Engineering (S/E) Fields

Objective:

To obtain information on changes in the quality of S/E students compared to (a) previous cohorts of S/E students and (b) current students in other fields.

Method:

The survey was conducted by the Higher Education Panel of the American Council on Education. The Panel includes a stratified sample of universities and colleges. The questionnaire was mailed in 1982 to 486 institutions with undergraduate programs and 383 institutions with graduate programs. The response rates were 80% and 78%, respectively. Weighted estimates were developed to represent all institutions at each degree level.

Major Findings:

A majority of senior academic officials believe that there has been no significant change in the quality of S/E students over the past five years. Sixty percent reported "no change" in quality of S/E undergraduate or graduate students. Although the majority of those queried indicated no change, most of the rest expressed views that point toward quality improvement. Officials at many institutions reported a shift of the most able undergraduate students toward S/E fields. Officials attributed this shift primarily to changes in perceptions about employment opportunities following receipt of the bachelor's degree. The graduate deans compared the quality of 1981/82 S/E doctorate recipients with those of 1976/77. The two groups were perceived by 66% of the deans to be equally qualified, but those who observed a quality difference generally favored the 1981/82 group.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Supply and Education Analysis Group

Institution/Principal Investigator:

American Council on Education/Frank J. Atelsek

Availability:

"No Change in Science and Engineering Student Quality Seen by 60% of Academic Officials: At Least 25% Perceive Improvement," *Highlights*, September 30, 1983, NSF 83-322, available from SRS/Editorial and Inquiries Unit. This survey report is expected to be available in fall 1983 from the Higher Education Panel, American Council on Education, One Dupont Circle, N.W., Washington, D.C. 20036, and from the National Technical Information Service, Springfield, Virginia 22161.

PROJECT:
The Role of Postdoctoral Education in the United States

Objective:

To study the role of postdoctoral education in the sciences as it has changed since the 1970's with increasing proportion of science doctorate recipients involved in postdoctoral appointments.

Method:

This project examines the trends in postdoctoral education and attempts to separate the influence of labor market conditions, such as the reduced number of tenure track positions available in academia, from the need for specialized education in a subject area. The research also examines the careers and other differences between those who become postdoctorates with those who do not, utilizing data from several existing surveys conducted over time by the National Research Council and the Higher Education Research Institute.

Major Findings:

Among the 1970's postdoctorates, the incidence of market-driven motivations—e.g., availability of employment—increased markedly. There is evidence that postdoctoral quality is declining in the biomedical sciences, psychology, the social sciences, and the humanities and that increasing proportions of postdoctorates in the late 1970's, compared to the early 1970's, underwent their training in lower quality academic departments. Compared to most postdoctorates in both the mid-sixty and early seventy cohorts, postdoctoral training for most fields was not cost-effective either in terms of subsequent salary or faculty positions obtained; there is, however, evidence of gains for former postdoctorates from recent doctoral cohorts, relative to their non-postdoctoral cohorts in salary and job attainment between 1979 and 1981.

The study also examines patterns of postdoctoral activity and labor-market success among women and minority scientists. Little difference was found in participation rates between women and men by discipline (limited to medical and biological scientists). Further, postdoctoral experience failed to help women achieve labor-market success. For the recent cohort studied, those women with postdoctoral experience were generally less successful as compared with their male counterparts than were those women without this experience as compared with their male counterparts. There was evidence that minority natural scientists (excluding Asians) were less likely to hold postdoctoral appointments than whites, and that this may be due to better starting salary offers to minority scientists.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

Higher Education Research Institute/William Zumeta

Availability:

Extending the Educational Ladder: The Changing Role of Postdoctoral Education in the United States. For information concerning the availability of this report, write or telephone the SRS/Utilization Studies Group.

section II. human resources

c. employment

PROJECT:
Academic Employment of Scientists and Engineers, 1982

Objective:

To provide annual quantitative information on professional science and engineering (S/E) personnel employed by universities and colleges.

Method:

Coordinators in 2,200 institutions with S/E programs received the questionnaire for the January 1982 survey. Data elements were level of educational attainment, discipline of employment, employment status (full- or part-time), sex, and total and R&D full-time equivalents. Responses were received from 89% of the doctorate-granting institutions, where two-thirds of the S/E professionals were employed. The survey was closed out in August 1982.

Major Findings:

S/E employment in the higher education sector continued to climb in 1982 to approximately 348,800. The 4% rate of increase over 1981, however, was slower than the growth rate for scientists and engineers in other economic sectors. Over 20% of the academic S/E work force was employed part time. The sharpest rise occurred in the mathematical/computer sciences, up 8% from 1981 to 1982, with more than one-half the increase attributable to the 18% gain in computer scientists.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Academic Employment of Scientists and Engineers Continued to Grow in 1982, but Slower than in Other Economic Sectors," *Highlights*, NSF 83-317, July 29, 1983, available from SRS/Editorial and Inquiries Unit, and *Academic Science/Engineering: Scientists and Engineers, January 1982*, Detailed Statistical Tables, NSF 83-311, National Technical Information Service, Springfield, Virginia 22161, PB 83-241927, $13.00 (paper copy), $4.50 (microfiche); also available from SRS/Editorial and Inquiries Unit. Access to the public-use tapes in the *Data User Guide*, May 1982, available from the RDESS/Universities and Nonprofit Insititutions Studies Group.

PROJECT:
Academic Employment of Scientists and Engineers, 1983

Objective:

To provide annual quantitative information on professional science and engineering (S/E) personnel employed in universities and colleges.

Method:

Coordinators in 2,200 institutions with S/E programs received the questionnaire for the January 1983 survey. Data elements were level of educational attainment, discipline of employment, employment status (full- or part-time), sex, and total and R&D full-time equivalents. The survey was closed out in July 1983.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator

[Intramural]

Availability:

It is anticipated that Detailed Statistical Tables will be published by summer 1984 and will be available from SRS/Editorial and Inquiries Unit.

PROJECT:
A Rapid Industry Limited-Response Survey Panel on Scientific and Engineering (S/E) Personnel Resources

Objective:

To acquire and disseminate information on the industrial labor market for S/E personnel so that policy can be formulated rapidly to meet urgent needs.

Method:

SRS established an industry panel of company representatives whose opinions and access to information can provide qualitative and quantitative information that is not readily available on a timely basis from any other source.

Major Findings:

The first survey, conducted in the fall of 1981, sought to identify the extent of reputed shortages of scientists and engineers. The survey found definite and likely shortages of persons trained in computer science; system analysis; and electrical/electronic, petroleum, and computer engineering. In a follow-up survey in the summer of 1982, over 50% of the firms indicated that it had become easier to hire new scientists and engineers. The only field where as much as 40% of employers reported shortages was electronic engineering at the master's-degree level.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Labor Markets for New Science and Engineering Graduates in Private Industry," *Highlights*, NSF 82-310, June 9, 1982, and "Labor Market Slackens for New Science and Engineering Graduates," *Highlights*, NSF 82-330, November 22, 1982, available from SRS/Editorial and Inquiries Unit.

PROJECT:
Scientists, Engineers, and Technicians in Private Industry

Objective:

To provide data on employment of scientists, engineers, and technicians in the private sector by occupation and industry of employment.

Method:

Annual surveys of employing establishments are conducted by State Employment Security Agencies in cooperation with the Bureau of Labor Statistics. The State data are combined into national estimates of employment by Standard Industrial Classification (SIC) code. This is an ongoing survey that began in 1977. Each year one of three subsectors (manufacturing, trade and regulated industries, or other nonmanufacturing) is surveyed.

Major Findings:

This project reports findings for establishments in manufacturing industries concern those represented within SIC categories 20-39. Employment of scientists, engineers, and technicians in manufacturing industries grew between 1977 and 1980 more than six times as fast as that of the overall work force—6% per year reaching 1,34[illegible],000. Most of this growth was generated by high-technology industries—electrical and nonelectrical machinery, transportation equipment, chemical, and instruments. Over this period, most manufacturing industries increased the share of their work force that consisted of scientific, engineering, and technical personnel. Those types of increases, as opposed to overall employment growth, accounted for 85% of the growth of scientists, engineers and technicians.

This project reports findings for establishments in nonmanufacturing industries represented within SIC categories 10-17, 60-67, and 70-89 that include mining, contract construction, finance, insurance, real estate, and service industries. Science, engineering, and technician (SET) occupations in these nonmanufacturing industries grew more than twice as fast as the overall workforce between 1977 and 1981—8.4% versus 3.4% per year. Most of this growth was concentrated within the business service and miscellaneous service industries and was related not to industrial expansion, but to the growing share of jobs being filled by SET personnel. Changes in staffing patterns accounted for more than half of the growth in SET employment over this period.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Scientists, Engineers, and Technicians in Manufacturing and Nonmanufacturing Industries: 1980-81, Detailed Statistical Tables, will be published in 1984 and available from SRS/Editorial and Inquiries Unit, "Manufacturing Employment Becomes Increasingly Technological," *Highlights*, NSF 83-303, March 10, 1983, and "Technical Employment Growth Accelerates in Selected Nonmanufacturing Industries," *Highlights*, NSF 83-321, October 17, 1983, available from SRS/Editorial and Inquiries Unit, and *Changing Employment Patterns of Scientists, Engineers, and Technicians in Manufacturing Industries: 1977-80*, Final Report, NSF 82-331, October 1982, National Technical Information Service, Springfield, Virginia 22161, PB 83-210690, $10.00 (paper copy), $4.00 (microfiche); also available from SRS/Editorial and Inquiries Unit.

section II. human resources

d. projections

PROJECT:
Computer Model Estimates of the Science and Engineering (S/E) Population

Objective:

To develop a computer model for the production of composite estimates of the demographic and employment characteristics of scientists and engineers in the United States, using the results of several SRS-sponsored surveys of S/E personnel resources.

Method:

The computer model (SETAB) consists of the three sets of routines. The first extracts information from the raw files and creates smaller microdata files that may be processed economically and rapidly. A second set manipulates the survey data by "aging" the data collected in one year to represent a population in a later year or to impute missing information. The third set produces a series of tables consistent in format with previously published NSF data. Data files and methods thus developed are being used to trace changes in the social, demographic, and employment characteristics of scientists and engineers. Among the characteristics that are being quantified are changes in sex and ethnic characteristics, labor-force status, occupation, sector of employment, and primary work activity.

Major Findings:

SETAB has been developed and is being used to produce tabulations of scientists and engineers for 1980, 1978, and 1976. Estimates for 1982 are being developed and estimates for prior years are being revised based on more recent information collected in 1982.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

Mathematica Policy Research, Inc./David Edson

Availability:

NA

PROJECT:
The Engineering Degree-Conferral Process—Analysis and Projections

Objective:

To develop a series of econometric models that project the supply of new engineering graduates by field of engineering, race, and sex.

Method:

The projections will be both short term (up to five years) and long term, and will be closely related to projections of the economic conditions that affect the market place for engineers, comparing them to past occupational-choice patterns of students.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

Engineering Manpower Commission/Patrick Sheridan

Availability:

Results are expected in the spring of 1984.

PROJECT:
Impact of Defense Buildup on the Scientific and Engineering (S/E) Work Force

Objective:

To assess the adequacy of the supply of scientists and engineers to meet the demands generated by the proposed defense buildup over the 1980-86 period.

Method:

The research entails utilization of the Defense Inter-Industry Forecasting System (DIFS) of Data Resources, Inc., to generate employment requirements by detailed occupation and industrial classifications in both the defense and nondefense sectors. Detailed occupational requirements generated by various combinations of defense expenditure patterns and macroeconomic conditions were compared to the projected supply of S/E personnel to identify possible shortages. The projected supply was derived by use of a dynamic simulation model that forecasts degree conferrals, curriculum choice, labor force participation, and occupational mobility. The latter model was developed under NSF support by Drs. Robert DauffenBach (Oklahoma State University) and Jack Fiorito (University of Iowa).

Major Findings:

Shortages representing at least a 10% shortfall in supply are projected for aeronautical/astronautical engineers and computer specialists. By 1987, the shortfall for the former is expected to vary from 15% to 45% representing approximately 10,000 to 35,000 personnel; for the latter, the comparable range is expected to be 15% to 30%, or about

115,000 to 140,000 personnel. At high projected levels of defense expenditures the shortfall of electrical/electronic engineers will be almost 10% of supply, or roughly 30,000 personnel. Increasing job opportunities and wage incentives can be expected to draw workers into these fields, helping to alleviate potential problems. These effects will be examined in a forthcoming report.

Projections of scientists, engineers, and technicians (SET) were more sensitive to variation in defense spending than to variations in macroeconomic activity because the former's impact is concentrated on high-technology manufacturing industries. Among SET occupations, defense expenditures have their strongest impact on the engineering workforce.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Projected Employment Scenarios Show Possible Shortages in Some Engineering and Computer Specialties," *Highlights*, NSF 83-307, February 23, 1983, available from SRS/Editorial and Inquiries Unit. A more complete report, including a description of methodology, is expected to be available from SRS/Editorial and Inquiries Unit by spring 1984.

section III. funding of science and technology

a. government

PROJECT:
Federal R&D Funding, FY 1981-83

Objective:

To develop comprehensive data and analyses of funding levels for R&D and R&D plant programs of Federal agencies in the 1983 budget. To present data and analyses based on a survey of all agencies sponsoring R&D programs, covering such categories as basic research, applied research, development, performing sectors, fields of science, and geographic (State) distribution.

Method:

The survey is a recurring one, using a questionnaire that is sent annually to all Federal agencies that support R&D programs. Agency subdivisions that respond to the survey are, for the most part, budget offices where records are maintained of past and ongoing program levels and latest budget request levels. Responses to the 1981-83 (volume XXXI) survey were received and reviewed by NSF by mid-July 1982. They were processed by computer in the form of 132 detailed statistical tables.

Major Findings:

In fiscal year 1983 total Federal R&D obligations (excluding R&D plant) are an estimated $43.0 billion, or 10% higher than the 1982 level. Most of this increase is the result of a sharp rise in anticipated development funding by the Department of Defense (DOD). Federal R&D obligations to industrial firms, including federally funded research and development centers (FFRDC'S), are expected to rise 15% in 1983, well ahead of any other R&D-performing sector. The increase is largely derived from DOD programs. R&D obligations to universities and colleges show an increase of 3% in 1983. The Department of Health and Human Resources is still the leading support agency, but in 1983 DOD is expected to move to second place in support to this sector, ahead of the National Science Foundation. An increase of 13% is anticipated in Federal development funding in 1983; an increase of 3% in applied research funding; and an increase of 9% in support to basic research, chiefly resulting from increases in the space, defense, and energy areas.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Government Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Federal Funds for Research and Development, Fiscal Years 1981, 1982, and 1983, Volume XXXI, Detailed Statistical Tables, NSF 82-326, were issued in early fall 1982 and are available from the National Technical Information Service, Springfield, Virginia 22161, and SRS/Editorial and Inquiries Unit. *Federal Funds for Research and Development, Historical Tables: Fiscal Years 1967-1983* is unpublished and is available from RDESS/Government Studies Group, upon request. A final report based on the volume XXXI survey will be published early in 1984.

PROJECT:
Federal R&D Funding, FY 1982-84

Objective:

To develop comprehensive data and analyses on funding levels for research and development and R&D plant programs of Federal agencies in the 1984 budget. To present data and analyses based on a survey of all agencies sponsoring R&D programs, covering such categories as basic research, applied research, development, performing sectors, fields of science, and geographic (State) distribution.

Method:

The survey is a recurring one, using a questionnaire that is sent annually to all Federal agencies that support R&D programs. Agency subdivisions that respond to the survey are, for the most part, budget offices where records are maintained of past and ongoing program levels and latest budget request levels. Responses to the 1982-84 (volume XXXII) survey were received and reviewed by NSF by mid-July 1983. They were processed by computer in the form of 133 detailed statistical tables.

Major Findings:

In FY 1984 total Federal R&D obligations (excluding R&D plant) are an estimated $45.5 billion, or 18% higher than the 1983 level. A relatively large share of this increase results from an estimated 31% growth to $26.2 billion in funding for development by the Department of Defense (DOD). DOD development funding represents nearly 85% of all Federal development support and 58% of total R&D spending for 1984. Basic research obligations were approximately 9% above 1983, reaching $6.6 billion. This increase reflects increased growth for the National Institutes of Health within the Department of Health and Human Services (HHS). Applied research shows a slight reduction to $8.0 billion in 1984 even though DOD, the leading support agency, increased 13% to $2.7 billion. R&D obligations to industrial firms, including federally funded research and development centers are expected to rise 27% in 1984 to $24.6 billion. These performing sectors are supported chiefly by DOD. Universities and colleges were expected to receive a 6% increase to $5.3 billion in Federal R&D obligations in 1984. This performing sector obtains most of its funding support from HHS. Federal research obligations in 1984 are expected to increase 2% to $5.3 billion for the life

sciences, 12% to $3.2 billion for the physical sciences, and 21% to $482 million for mathematical and computer sciences. Reductions are planned for engineering, .4% to $3.5 billion, and the environmental sciences, 3% to $1.2 billion.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Government Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Federal Funds for Research and Development, Fiscal Years 1982, 1983, and 1984, Volume XXXII, Detailed Statistical Tables, NSF 83-319, will be issued in early 1984 and will be available from the National Technical Information Service, Springfield, Virginia 22161, and SRS/Editorial and Inquiries Unit. *Federal Funds for Research and Development, Historical Tables: Fiscal Years 1967-84* is unpublished and will be available gratis by November from RDESS/Government Studies Group, upon request. A final report based on the Volume XXXII survey will be published early in 1984. *Highlights* will be published late in 1983 and available from SRS/Editorial and Inquiries Unit.

PROJECT:
Federal R&D Programs by Budget Function, FY 1981-83

Objective:

To provide a complete overview of Federal R&D program planning and to offer a record of amounts requested in the 1983 budget. Also to afford a view of R&D amounts as shares of total budget function amounts, and to provide a means of quickly assessing relative priorities given to various R&D functional areas and various R&D programs within the Federal R&D total. To provide a basis for keeping track of subsequent congressional appropriation actions subsequent to the budget presentation. The report groups approximately 600 R&D programs included in the 1983 Federal budget by budget function. Tables are accompanied by brief descriptions of funding changes for specific programs.

Method:

Sources of funding data were reports provided by the agencies to the Office of Management and Budget for *Special Analysis K: Research and Development* in the 1983 budget, presented in February 1982, plus agency budget justification documents prepared for the Congress, and some information provided informally by some of the smaller R&D support agencies. The data were developed and arranged by budget function by NSF/SRS staff, and descriptions of budget changes were produced from budget documents.

Major Findings:

Total R&D budget authority in the 1983 budget was $43,174 million, 12% more than the 1982 total of $38,701 million. Nearly all R&D growth was focused in the national defense area, which showed projected growth of $4,412 million, or 20%, 1983 over 1982. An increase of $657 million, or 12%, was shown for space research and technology with an emphasis on space shuttle flight operations and space science. A net decrease of $594 million, or 5%, for nondefense/nonspace R&D programs in 1983 followed a decrease of $952 million, or 8%, in 1982. An increase of 9% for total Federal basic research in 1983, to $5.9 billion compared with an increase of 8% in 1983 for the Federal total excluding defense basic research. The share of national defense within the Federal R&D total was an estimated 61% in the 1983 budget, compared with 57% in 1982.

Responsible SRS Organization:

R&D Economic Studies Section/Government Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Federal R&D Funding by Budget Function: Fiscal Years 1980-83, April 1982, and "Defense Leads R&D Growth in FY 1983—Energy and Natural Resources and Environment Fall Sharply," *Highlights*, NSF 82-322, August 1982, available from SRS/Editorial and Inquiries Unit.

PROJECT:
Federal R&D Programs By Budget Function, FY 1982-84

Objective:

To provide a complete overview of Federal R&D program planning and to offer a record of amounts requested in the 1984 budget. Also to afford a view of R&D amounts as shares of total budget function amounts, and to provide a means of quickly assessing relative priorities given to various R&D functional areas and various R&D programs within the Federal R&D total. To provide a basis for keeping track of subsequent congressional appropriation actions subsequent to the budget presentation. The report groups approximately 600 R&D programs included in the 1984 Federal budget by budget function. Tables are accompanied by brief descriptions of funding changes for specific programs.

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Sources of funding data were reports provided by the agencies to the Office of Management and Budget for *Special Analysis K: Research and Development* in the 1984 budget, presented

in January 1983, plus agency budget justification documents prepared for the Congress, and some information provided informally by some of the smaller R&D support agencies. The data were developed and arranged by budget function by NSF/SRS staff, and descriptions of budget changes were produced from budget documents.

Major Findings:

Total budget authority for all R&D programs, as proposed in the 1984 budget, is $45,663 million, 19% higher than the 1983 total of $38,455 million, allowing for considerable real growth. This increase contrasts with the 6% increase in 1984 budget authority in the overall Federal budget. The 1984 budget continued to embody efforts made in the two previous budgets to reduce the growth of overall Federal spending by eliminating activities that overstep the bounds of proper Federal responsibilities and restraining growth in other areas. Federal R&D support was targeted especially at national security, basic research, and long-term energy technologies, such as magnetic fusion. Within basic research special emphasis was given to the physical sciences and engineering as an aid to national defense and to U.S. competitiveness in high technology industries. High priority is given in the 1984 budget, as in the 1983 budget, to improving national defense capabilities. In the three most recent budgets consistent real increases have been provided to defense and consistent decreases to energy and natural resources and environment programs, with the largest decreases directed to energy.

Responsible SRS Organization:

R&D Economic Studies Section/Government Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Federal R&D Funding by Budget Function: Fiscal Years 1982-84, April 1983, available from SRS/Editorial and Inquiries Unit.

PROJECT:
Federal R&D Funds for the Energy Budget Function: FY 1971-84

Objective:

To examine the nature and scope of R&D funding on the part of the energy-related programs of the Department of Energy, the Nuclear Regulatory Commission, and the Environmental Protection Agency. To provide a perspective on some of the actions taken by four successive administrations to meet national energy problems placed within a broader setting of Federal R&D support.

Method:

Data presented in this analysis are derived from the NSF compilations of Federal R&D funding by budget function for fiscal years 1971 through 1984 excluding plant data. These data provide the framework for the discussion of support trends and for an analysis of program interrelationships.

Major Findings:

Since the start of the seventies three funding patterns are evident in Federal R&D support to energy. In the 1971-74 period, growth in funding was fairly rapid; although at an average rate of 10.9% per year, this still did not represent the fastest-growing area of R&D investment. In the 1974-80 period, the rate of funding rose to an unprecedented 30.0% annually, higher than for any other budget function. The 1980-84 period embodied a reversal: based on the 1984 budget, the average annual rate of decline for energy was 11.4% greater than for any major function. Continued support is given to nuclear programs of a long-run, high-risk nature that are beyond the present capabilities of private industry, as well as to basic research in the energy sciences.

Responsible SRS Organization:

R&D Economic Studies Section/Government Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Federal R&D Funding for Energy: Fiscal Year 1971-84, Special Report, NSF 83-301, February 1983, available from the SRS/Editorial and Inquiries Unit; available from National Technical Information Service, Springfield, Virginia 22161, PB 83-225318, $8.50 (paper copy), $4.50 (microfiche).

PROJECT:
Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, FY 1981

Objective:

To develop annual data from the Federal agencies believed to fund the largest programs in support of academic science/engineering (S/E) activities, particularly research and development.

Method:

Fifteen agencies received instruction booklets and institutional Code Books defining the obligations and disciplines concerned for FY 1981. There were four data elements: Agency, academic institution, discipline, and activity (R&D, R&D plant, facilities/equipment, fellowships/traineeships/training

grants, general S/E support, and other S/E and non-S/E activities). The survey was closed out August 1982.

Major Findings:

Obligations from Federal agencies to universities and colleges from FY 1980 to FY 1981 decreased by 15% in constant 1972 (deflated) dollars, in contrast to an increase during the previous 4-year period (3% in real terms). Universities granting S/E doctoral or equivalent degrees (including health professional) received four-fifths of all Federal academic support. In real-dollar terms, the overall R&D obligations total declined by 3% during the year.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Federal Science/Engineering (S/E) Support to Universities and Colleges Rose by 6% in FY 1981; Non-S/E Support Down 25%," *Highlights*, NSF 83-306, March 15, 1983, available from SRS/Editorial and Inquiries Unit; *Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, Fiscal Year 1981*, Final Report, NSF 83-315, June 1983, will be available from National Technical Information Service, Springfield, Virginia 22161, and from SRS/Editorial and Inquiries Unit. Access to the public-use tapes and documentation for their use are described in the *Data User Guide* and *Addendum*, May 1982 and February 1983, available from the RDESS/Universities and Nonprofit Institutions Studies Group.

PROJECT:

Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, FY 1982

Objective:

To develop annual data from the Federal agencies believed to fund the largest programs in support of academic science/engineering (S/E) activities, particularly research and development.

Method:

Fifteen agencies received instruction booklets and institutional Code Books defining the obligations and disciplines concerned for FY 1982. There were four data elements: Agency, academic institution, discipline, and activity (R&D, R&D plant, instructional facilities/equipment, fellowships/traineeships/training grants, general S/E support, and other S/E and non-S/E activities). The survey was closed out in June 1983.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

The Final Report for FY 1982 will include Detailed Statistical Tables, and it is anticipated that it and the *Highlights* for FY 1982 will be published in 1984. It will be available from SRS/Editorial and Inquiries Unit.

section III. funding of science and technology

b. industry

PROJECT:
Comparing Industrial R&D Expenditures with Selected Corporate Financial Indicators

Objective:

To determine if there are published corporate financial indicators that can be used (either alone or in conjunction with the traditional R&D/net sales ratios published by NSF) to provide a better assessment of the capability and willingness of U.S. industry to invest in research and development, than is currently possible by using R&D/net sales ratios alone.

Method:

Data that are publicly available from the company annual reports and from Securities and Exchange Commission 10K forms of the largest R&D firms in selected industries are being examined, and an individual firm's R&D expenditures for a 10-year period have been correlated to that firm's net sales, cash flow, and capital expenditures. Implications for the selected industries as a whole may be drawn on the basis of data from the firms included in the study.

Major Findings:

A preliminary comparison of the relationship between industrial R&D expenditures and corporate cash flow in the firms under study reveals that this ratio generally ranges between 25% and 30%. The results tend to confirm anecdotal information that corporations attempt to keep the growth of R&D expenditures compatible with their outlook for net sales and/or profits.

Responsible SRS Organization:

R&D Economic Studies Section

Institution/Principal Investigator:

[Intramural]

Availability:

A final report is expected to be available from SRS/Editorial and Inquiries Unit at the end of 1983.

PROJECT:
Developing Strategies for Augmenting Response to the NSF Industrial R&D Survey

Objective:

To determine whether the rate of response to the voluntary section of the NSF annual survey of industrial research and development can be improved by examining the rationale used by firms in determining the extent to which they choose to participate in nonmandatory government surveys.

Method:

The project will include 10 site visits by TARP, Inc., and the NSF Division of Science Resources Studies (SRS) staff to major R&D performers. On the basis of these visits, preliminary models of the response decision-making process will be developed. About 80 telephone interviews with officials in other firms will then be conducted by TARP and SRS staff. TARP will summarize these findings in a final report and include recommendations for feasible strategies that could motivate the key decision makers to encourage their companies to increase participation in the voluntary portion of the survey.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

TARP, Inc./John A. Goodman

Availability:

Report expected to be completed in summer 1984 and available in the SRS/Industry Studies Group.

PROJECT:
Estimates of Company-funded Industrial R&D Expenditures for 1983-84

Objective:

To provide estimates of companies' own financing of research and development in major industries for 1983-84 and to identify such factors as the Economic Recovery Tax Act (ERTA) of 1981 that will affect the funding of these activities.

Method:

The report is based on information obtained from two major sources: (1) Mail responses to an inquiry sent to the members of the NSF Industrial Panel on Science and Technology, and (2) interviews with R&D officials representing firms in the major R&D-performing industries. Of the 97 company representatives contacted during April-July 1983, replies were received from 76. The respondents were asked to estimate the growth, if any, in company-funded R&D expenditures during 1983-84 over the previous years, and to identify the factors they believed to be responsible for any changes. They were also asked to assess the effect of R&D tax credits from ERTA on their R&D budgets.

Major Findings:

Total company-funded expenditures for research and

development in the United States are estimated to be $43 billion in 1983, an increase of about 9% over 1982. As of mid-1983, most company R&D officials are anticipating a higher rate of growth in research and development for 1984, resulting in an estimated increase of 11% in company-funded R&D activities over 1983. Limiting factors behind these overall R&D expenditure growth rates are economic uncertainty, lower profits in 1982, and the fear of the return of high interest rates. According to 37% of the respondents, their R&D budgets were influenced by the R&D tax credits in ERTA. R&D directors said the tax credits were beneficial in maintaining R&D budgets during the recent corporate cost-cutting period and in accelerating the timing of certain R&D projects already underway.

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Highlights should be available from SRS/Editorial and Inquiries Unit in late 1983.

PROJECT:
Feasibility of Developing Integrated Sets of Industrial R&D Economic Data

Objective:

To develop an internally consistent data bank for exploring relationships between industrial R&D expenditures and the economy.

Method:

Specifications for a user-oriented data set were developed, and an inventory of alternative R&D data bases was taken. Each data base was evaluated in terms of its validity, reliability, compatibility with other data sources, and usefulness. Alternative strategies for augmenting the NSF/Census industrial R&D data base were developed through the use of other data bases or through minor modifications of existing data collection procedures. During the course of the study, information regarding specific details of these data bases were obtained from government agencies, trade associations, and corporations. The feasibility study can provide a basis for the development of an integrated set of industrial R&D and economic data bases.

Major Findings:

After examining 18 data bases, TARP recommended that all but 4 be eliminated from consideration at the present time: 1) Economic Information Services (EIS); 2) University of Pennsylvania/SRI International/Bureau of Census; 3) Strategic Planning Institute; and 4) Bureau of Labor Statistics employment data. TARP concluded that only the EIS data set held sufficient potential for immediate followup. For EIS, establishment data can be aggregated to derive essentially the same "enterprise data" as those available from Census.

Also included in the report are suggestions for improving the industrial R&D survey that were made by some of the officials interviewed.

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

TARP, Inc.

Availability:

An Examination of Possible Linkages Between the National Science Foundation's Industrial R&D Data Set and Other Economic Data Bases. Final Report; available from the National Technical Information Service, Springfield, Virginia 22161, PB 83-132761, $10.00 (paper copy), $4.50 (microfiche).

PROJECT:
Research and Development in Industry, 1981

Objective:

To provide data on the resources allocated to research and development by domestic firms. These statistics are published annually and presented historical trend information in addition to current survey-year data.

Method:

The annual survey of industrial research and development is conducted by the Bureau of the Census for NSF. Companies surveyed are selected from a sample that consists of 15,000 companies. All manufacturing and selected nonmanufacturing companies with 500 or more employees are surveyed every year; those with fewer than 500 employees are surveyed at rates depending upon the industry and the amount spent on research and development. In the absence of respondent-distributed data, the Census Bureau estimates data in accordance with past performances and industry averages.

Major Findings:

Industrial firms reported expenditures totaling $52 billion in 1981, 17% above the 1980 level. After adjustment for inflation, the 1981 increase was 7%, well above the 5.4% average annual rate of growth registered between 1975 and 1980. Companies' own financing, which accounts for two-

thirds of total industrial R&D expenditures, rose 6% in constant dollars during 1981, that portion of industrial research and development supported by the Federal Government rose 7% in constant dollars. Companies in the aircraft and missiles industry reported the highest overall percentage increase—27% in current dollars—in 1981 R&D outlays. This gain is largely attributable to an acceleration in R&D funding by the Department of Defense. Over half a million R&D scientists and engineers were employed by companies in January 1982, a gain of 5% over the January 1981 level.

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

[Intramural]

Availability

"Company and Federal Support Produce 17% Industrial R&D Spending Increase in 1981," *Highlights*, NSF 83-313, August 8, 1983, available from SRS/Editorial and Inquiries Unit. It is expected that the *Detailed Statistical Tables* and *Final Report* will be available in early 1984 from SRS/Editorial and Inquiries Unit.

PROJECT:
R&D Expenditures in the Service Industries

Objective:

To develop better estimates of current service sector R&D expenditures and to recommend methodology for continued improvement in the measurement of service sector R&D activities; to provide some insight into how R&D funding levels and performance are determined by service sector managers.

Method:

The research will be developed in three phases: (1) R&D managers from firms in five service industries will be interviewed in an attempt to understand the process behind their R&D expenditures—i.e., what determines whether their needs will be satisfied internally or externally, who eventually does the research and development, etc.; (2) Extant public data of 100 manufacturing companies will be analyzed to estimate the proportion of their R&D expenditures that might be more appropriately classified as service sector R&D; and (3) The findings will be integrated to provide insights into the potential impact of the service sector on total research and development, as well as to develop methodological suggestions designed to improve data collection on the R&D activities of the service industries.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

Cooper and Company

Availability:

Report expected to be available early in 1985 from SRS/Industry Studies Group.

PROJECT:
Trends in Industrial Basic Research Expenditures

Objective:

To examine trends and provide estimates of spending by companies of their own funds on basic research and to outline the factors that have affected or will be affecting the funding of basic research projects in 1981 and 1982.

Method:

The report was based on information obtained from two sources: (1) Mail responses to an inquiry sent to the members of the NSF Industrial Panel on Science and Technology, and (2) interviews with other R&D officials representing firms in the major R&D-performing industries. The respondents were asked to estimate the growth, if any, in company-funded basic research expenditures over the previous year for 1981 and 1982 and to describe factors they believed to be responsible for any changes.

Major Findings:

Funding of basic research by industry slowed in 1982 except in the chemicals industry where there is a special emphasis on biotechnology, particularly genetic engineering. Industry is increasing its funding of basic research by universities and colleges because of an apparent shift of academic goals to areas of greater interest to industry, new developments in biotechnology, and a recognition by many firms that a byproduct of academic research is the training of scientists and engineers for industry.

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Trends to 1982 in Industrial Support of Basic Research, Final

Report, NSF 83-302, available from SRS/Editorial and Inquiries Unit.

PROJECT:

Venture Capital Investment in Small, High-Technology Companies

Objective:

To estimate the venture capital industry's total annual funding of small companies, to estimate the funding of high-technology companies, and to distribute the funding by field of technology.

Method:

Use of a data base collected by the Venture Economics Company covering new financing by venture capital companies.

Major Findings:

Venture funding increased markedly from the low in 1975 to 1980. The high-technology share has scarcely changed. Computer-related financings are the most frequent, but energy-related funding increased notably from 1975 to 1980.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Venture Economics/Norman D. Fast

Availability:

Venture Capital Investments and Small, High-Technology Companies: A Measure of the High-Technology Small Business Sector, is available for inspection in SRS/Science Indicators Unit.

section III. funding of science and technology

c. universities, colleges, and other nonprofit organizations

PROJECT:
NSF Baseline Survey of Major Academic Research Instruments in Academic Settings

Objective:

To develop quantitative indicators of the status of, and need for, equipment for scientific research in U.S. universities and colleges through a nationally representative survey of higher education institutions.

Method:

The contractor will conduct a stratified probability sample of 43 universities from a universe of the approximately 160 largest academic R&D performers. Phase I of the survey will subsample departments within universities in the physical and computer sciences and engineering, collecting information on equipment costing at least $10,000. This study is based on the "Instrumentation Indicators Feasibility Study" completed for NSF by Westat, Inc., in early 1982. Phase II of this projected 3-year study will subsample departments within universities in the biological, agricultural, and environmental sciences.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

Westat, Inc./Lance Hodes

Availability:

"Universities Spent 6% of Separately Budgeted R&D Expenditures for Research Equipment in 1980," *Highlights*, NSF 82-316, June 14, 1982, available from SRS/Editorial and Inquiries Unit. Other publications resulting from this survey are projected to be available from SRS/Editorial and Inquiries Unit during 1984.

PROJECT:
Comparative Trends in Academic Research Capacity Among Major Disciplines

Objective:

To analyze trends in the patterns of academic R&D spending and personnel utilization among the major scientific and engineering (S/E) disciplines for the period 1977/78 to 1980/81 in a special study.

Method:

To merge several data bases related to academic S/E resources in order to create and compare indicators of academic research capacity. Several data elements are being analyzed and compared for each discipline: Level of R&D spending, ratio of R&D spending to professional staff size, utilization of graduate research assistants, level of federally financed R&D spending, extent of shifts between teaching and research activities, and trends in enrollment and degrees granted.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

The special study is expected to be published during FY 1984 and will be available from SRS/Editorial and Inquiries Unit.

PROJECT:
R&D Funds in Academic Science and Engineering, FY 1981

Objective:

To collect annual data from academic institutions spending over $50,000 for separately budgeted research and development.

Method:

FY 1981 data were tabulated and analyzed based on responses to questionnaires from 86% of the 563 institutions and their affiliated federally financed R&D centers. There were several data elements: Source of support, amount allocated to basic research, both total and federally financed R&D expenditures by discipline, research equipment expenditures from separately budgeted R&D funds by discipline, and capital expenditures for scientific and engineering (S/E) activities. The survey was closed out in August 1982.

Major Findings:

Academic separately budgeted R&D expenditures in FY 1981 in constant 1972 (deflated) dollars increased 2% over FY 1980. Federally funded R&D support showed a 1% constant-dollar increase during the same time. Industry funding of academic research and development was up by 10% in constant dollars. Academic basic research expenditures

increased by 3% in constant dollars, accounting for two-thirds of all academic R&D activities. Expenditures for S/E research equipment accounted for about 6% of total academic R&D spending.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Real Growth Rate of Academic R&D Expenditures Slowed to 2% in FY 1981," *Highlights*, NSF 83-304, March 21, 1983, available from SRS/Editorial and Inquiries Unit; *Academic Science/Engineering: R&D Funds, Fiscal Year 1981*, Detailed Statistical Tables, NSF 83-308, June 1983, National Technical Information Service, Springfield, Virginia 22161, PB 83-228213, $16.00 (paper copy), $4.50 (microfiche); also available from SRS/Editorial and Inquiries Unit. Access to the public-use tapes and documentation for their use are described in the *Data User Guide* and *Addendum*, May 1982 and February 1983, available from the RDESS/Universities and Nonprofit Institutions Studies Group.

PROJECT:
R&D Funds in Academic Science and Engineering, FY 1982

Objective:

To collect data from academic institutions spending over $50,000 for separately budgeted research and development.

Method:

Five hundred sixty institutions and 19 affiliated federally financed R&D centers received the questionnaires for the FY 1982 survey. There were several data elements: Source of support, amount allocated to basic research, both total and federally financed R&D expenditures by discipline, research equipment expenditures from separately budgeted R&D funds by discipline, and capital expenditures for scientific and engineering activities. The survey was closed out in June 1983.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

It is anticipated that Detailed Statistical Tables will be published by summer 1984, and will be available from SRS/Editorial and Inquiries Unit.

section III. funding of science and technology

d. other

PROJECT:
Construction of Price Indexes for R&D Inputs

Objective:

To develop a set of price indexes for industrial R&D expenditures for use in economic analysis and policy research.

Method:

The study will build on previous work in the area for the years 1969 and 1979 to obtain price indexes for a sample of firms in eight industries for 1980, 1981, and 1982. Indexes in four other industries will also be developed. An evaluation of various R&D price indexes based on proxies will also be undertaken as well as an investigation of the factors responsible for differences among R&D inputs in their rate of price increase.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section

Institution/Principal Investigator:

University of Pennsylvania/Edwin Mansfield

Availability:

Expected date of publication: July 1985.

section IV. outputs and impacts

a. innovations and inventions

PROJECT:
Conference on Methods for Measuring Technological Progress

Objective:

To bring together experts who will discuss and compare various methods for measuring the advance in individual technologies with time.

Method:

A workshop will be held at which papers will be presented and discussed. The workshop coordinator will prepare a report that will include the presentations and summaries of the discussion together with an evaluation of the individual methods.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

University of Dayton/Joseph P. Martino

Availability:

Final report will be obtainable in early 1984 from the SRS/Science Indicators Unit.

PROJECT:
Development of Indicators of Technological Innovation Using Patent Examiners' Citations

Objective:

To develop indicators that differentiate between patents that are significant technically or commercially, and those that are less so.

Method:

Each patent was weighted by the number of times it was cited by examiners of subsequent patents. All examiner citations associated with patents issued during the 1970-80 period were tabulated to determine which patents issued during the 1970-77 period were among the most frequently referenced. The cited patents were grouped into 55 product fields and were disaggregated by nationality (U.S. vs. foreign) of inventor and owner. Interviews were conducted with patent examiners and, for a sample of patents, analyses were made of the complete files.

Major Findings:

Phase I of this project demonstrated that the commercial or technical importance of a patent is likely to be related to the frequency with which it is cited. Those patents considered important were cited two and one-half times more often on the average than the randomly-selected control set. Phase II showed the product fields in which U.S.-origin patents were relatively highly cited in 1977, as well as the fields in which the citation rate was below the rate for foreign-origin patents.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Computer Horizons, Inc./Mark P. Carpenter

Availability:

Development of Refined Indicators of Technology Innovation Using Examiners Citations in the Patent File—Phase I, National Technical Information Service, Springfield, Virginia 22161, PB 82-101833, $6.50 (paper copy), $3.50 (microfiche): Mark P. Carpenter, Francis Narin, and Patricia Woolf, "Citation Rates to Technologically Important Patents," *World Patent Information, Vol. 3, No. 4, 1981, pp. 160-163. Development of Indicators of Technoloical Innovation Using Patent Examiners' Citations,* Computer Horizons, Inc., 1983.

PROJECT:
The Measurement of Technological Change

Objective:

To extend the author's previous work so as to develop a method of measuring technological progress. To apply the method to digital computers, farm tractors, and electromicroscopes or similar instruments. To compare the results with those obtained by using other methods.

Method:

For each technology, determine surfaces of constant probability density in terms of the performance variables. Determine the distance between surfaces probabilistically by an application of discriminant functions. This distance represents the amount of progress from one surface to another. Dimensional analysis will be investigated as a way of reducing the number of variables to be studied.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

New York University/Devendra Sahal

Availability:

Final Report is expected in spring 1984.

PROJECT:
Measuring Technological Progress Through Tradeoff Surfaces

Objective:

To develop a measure of level of technological performance for technologies that are characterized by more than one performance characteristic; to extend an existing method for this purpose. To apply the method to three technologies probably to be selected from among computers, farm tractors, liquid fuel rocket engines, electric and aircraft generators.

Method:

For each technology, group the devices into sets that are equivalent in performance. Fit each set with a tradeoff surface in multidimensional space. Define a distance measure between the surfaces that will represent the degree of progress from one to another.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

University of Dayton/Joseph P. Martino

Availability:

Final report is expected in spring 1984.

PROJECT:
Measuring Technical Change Through Product Attributes

Objective:

To extend the investigator's previously developed method of measuring the progress of a given technology over time. The method combines the important quantitative features of the technology into a single index. To apply the improved method to jet engines, airframes, and aircraft, and to milling machines.

Method:

An R&D production function, a cost function, a demand function, and a profit function will be developed and then integrated into an overall decision model. Various curve-fitting techniques for estimating the technological trend equation from the model will be studied.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Rand Corporation/Arthur Alexander

Availability:

Final report is expected in spring 1984.

PROJECT:
Patenting in the United States by Various Countries in Various Fields of Technology

Objective:

To provide current and time-series data on patenting in the United States for 55 product fields and 10 designated technology fields, analyzed by country of origin, sector of patent owner, year of patent application, and year of patent grant.

Method:

Data are based on the computer file of patenting data of the Office of Technology Assessment and Forecast. They are converted from the Patent Office Classification system to the Standard Industrial Classification system for 55 product fields, by a computer program.

Major Findings:

Data covering the years 1963-81 show the increasing importance of foreign inventions and some decline in patenting by U.S. industry.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Office of Technology Assessment and Forecast, U.S. Patent and Trademark Office/John F. Terapane.

Availability:

Final report is expected in summer 1984.

PROJECT:
Patent Office Concordance Review and Workshop

Objective:

To update and improve the "concordance," the computer program developed by the Patent Office to convert patent counts classified in terms of the Patent Office classification system to the Standard Industrial Classification.

Method:

Complete documentation for the concordance will be developed and studied. A workshop of experts in the use of patenting data will make criticisms and suggestions. A final report to NSF will summarize these steps and make recommendations for changes in the concordance. Changes agreed upon will be implemented.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Office of Technology Assessment and Forecast, U.S. Patent and Trademark Office/John F. Terapane

Availability:

Final report will be available in summer 1984 from the SRS/Science Indicators Unit.

PROJECT:
Relative Share of World Patents in National Patent Markets

Objective:

To study the relative technical advantage of the United States, as represented by patenting data, in comparison with West Germany, Japan, the United Kingdom, and France, in various product fields and in two time periods.

Method:

The international patent file provided by Derwent will be used to determine the rates of patenting by these countries in various recipient countries in 1975-77 and 1980-82 in each of five R&D-intensive product fields. Revealed Advantage Indices will be calculated and plotted to show the areas of U.S. strength and weakness and changes in those areas.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Office of Technology Assessment and Forecast, U.S. Patent and Trademark Office/John F. Terapane

Availability:

Final report will be available in summer 1984 from the SRS/Science Indicators Unit.

section IV. outputs and impacts

b. bibliometrics

PROJECT:
Co-Citation Cluster Development as Science Indicators

Objective

To develop a new indicator of scientific progress based on co-citation cluster analysis methodologies.

Method:

Co-citation clusters drawn from the *Science Citation Index* data base are being screened to determine year-to-year continuities. Quantitative characteristics of these clusters are being studied to monitor important developments in research specialties, as reflected in the research literature.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Institute for Scientific Information/H. Roberts Coward

Availability:

Final report is expected in early 1984.

PROJECT:
Cross-National Bibliometric Comparisons

Objective:

To examine differences in the bibliometric characteristics of research papers from different countries, field by field, in order to see if these differences significantly affect the interpretation of current publication and citation indicators.

Method:

Bibliometric analyses will be conducted on publications from 15 countries using the *Science Citation Index* source tapes. All of the citation data to be used in the cross-country analyses will be developed from the exact-matched citation tapes. The project will provide several new indicators of the output of research including the rapidity of a nation's use of research results in subsequent research, international differences in the use of basic research findings in applied research, and changes in the quantity of research described in the average report. This project will also test some of the operating assumptions that underlie the literature indicators used in the *Science Indicators* reports.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Computer Horizons, Inc./Francis Narin

Availability:

Final report is expected in fall 1983.

PROJECT:
Updating and Maintaining Bibliometric Data Series

Objective:

To update the statistical data set of scientific and technical literature indicators used in the *Science Indicators* reports of the National Science Board, and to prepare an analytic report on selected technical aspects of the indicators methodology.

Method:

Data from the *Science Citation Index* issued by the Institute for Scientific Information will be compiled into measures and indices of scientific and technical publications and citations. Data will be disaggregated by field and subfield, by countries of authors and of journals, by levels of research (basic and applied), and by U.S. R&D-performing sectors. They will aiso show the most active institutions in each sector, and cooperatively authored articles.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Computer Horizons, Inc./Mark P. Carpenter

Availability:

Final report will be obtainable in summer 1984 from the SRS/Science Indicators Unit.

section IV. outputs and impacts

c. economic implications

PROJECT:

The Relationship of Agricultural Research and Development to Selected Socioeconomic Change in the Farm Sector

Objective:

To examine the impact of agricultural research and development on selected characteristics of the U.S. farm sector and to assess the validity and reliability of various agricultural R&D indicators such as expenditure and scientific personnel data.

Method:

The research will focus on possible relationships between research and development and changes in farm commercialization and concentration and in the farm labor force for the Nation as a whole. The project will examine different types of R&D output, levels of effort to diffuse such outputs, and the resultant effects. A comprehensive longitudinal data set will be created for research and development in the agricultural sector for the postwar period (1948-79).

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

University of Kentucky Research Foundation/Lawrence H. Busch

Availability:

Final report is expected in early 1984.

section IV. outputs and impacts

d. other

PROJECT:
Assessment of Science: The Development and Testing of Indicators of Quality

Objective:

To examine comprehensively a major dimension of science that has not been amenable to the development of indicators, although it is widely felt to be a significant aspect—quality. To explore the conversion of existing quantitative indicators into indicators of the quality of science.

Method:

A year-long series of monthly seminars, coupled with special commissioned papers, will lead to the identification of indicators that will be evaluated by representative scientists and nonscientists. Results will be released in a collection of essays, research papers, and book-length monograph.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Harvard University/Gerald Holton

Availability:

"On Developing Indicators of Quality in Science and Technology," Special Issue of *Science, Technology and Human Values*, Vol. 7 (Spring and Winter 1982).

PROJECT:
Attitudes of the Attentive Public and of Nongovernmental Policy Leaders Towards Science and Technology

Objective:

To produce survey data on the attitudes toward science and technology of several groups, including opinion leaders in science and technology (S/T) policy outside the Government and the portion of the public that is most interested in and informed about S/T issues.

Method:

Two questionnaires were designed, partly overlapping the one used in the 1979 national survey for *Science Indicators*, with the nationwide survey conducted by telephone. Responses were compared with those from the 1979 study.

Major Findings:

Opinions were obtained from samples of the broad public, an "attentive public" knowledgeable about and interested in S/T issues, a potentially attentive group, and opinion leaders in S/T policy outside the Government. The attentives' assessment of the benefits from S/T was found to be even more favorable than that of the general public, with potential attentives falling in between. Policy leaders are still more favorably disposed and have a greater preference for basic, as opposed to applied, research.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Northern Illinois University/Jon D. Miller

Availability

Final Report will be obtainable in early 1984 from the Principal Investigator.

PROJECT:
Examination of New Science and Technology Indicators

Objective:

To examine the feasibility of expanding the collection, analysis, and dissemination of information that can serve as new indicators of industrial innovative activity.

Method:

The investigator will review the literature on models of the innovation process in various sectors and circumstances. After developing a general model, including a preliminary set of indicators, the feasibility of collecting data and information for each of the trial subset of indicators will be examined through interviews with a small number of R&D officials in industrial firms. The information obtained from these discussions will then be used to refine the trial indicators and to identify a small subset. A final test using a mail survey will be conducted and the results, including the final set of indicators, will be discussed in the final report.

Major Findings:

It is possible to design a variety of new indicators of industrial innovation, and it is also feasible to collect the data needed to construct such indicators via a mail survey of industrial firms. Although problems regarding some of the 17 indicator questions used in the survey remain to be solved, the survey results argue strongly in favor of further data collection for the new indicators.

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

Massachusetts Institute of Technology/Christopher T. Hill

Availability:

An Executive Summary of the full report, *New Indicators of Industrial Innovation*, will be available in fall 1983 from SRS/Editorial and Inquiries Unit.

PROJECT:
Indicators of Interdisciplinary Research

Objective:

To define and begin to measure the extent of interdisciplinary scientific research.

Method:

A sample of 285 "Classics" articles described in *Current Contents* (1981) was examined for apparent interdisciplinary research. Eleven interdisciplinary articles were chosen and data compiled showing the number of times each classic was cited during the 10 years subsequent to publication, and the name of the journal in which the article citing the classic was published. The second component of the project sought to determine whether it is possible to distinguish disciplinary from interdisciplinary journals. Two journals were selected from each of 10 science and engineering areas, and from these journals 383 articles were drawn for analysis. Articles were analyzed for the number of authors per article, "interdisciplinariness" of the article, and subject classification of the references found in the article. The third component of the project was the application of the most promising journal-based indicator to a broader set of journals.

Major Findings:

Using the Institute for Scientific Information's subject categories, the investigators found a median of 39% of the citations to the "Classics" articles to be in the same subject category as the article. The striking finding was that the 11 articles were extremely idiosyncratic with respect to the amount of cross-category citing and the pattern over time. The analysis of scientific journals yielded an indicator of "cross-categorical referencing," a measure of the percentage of refences outside a journal's subject category. Application of this indicator to a selected set of journals in three areas (toxicology, demography, and operations research/management science) for the years 1976 and 1982 revealed remarkable stability over time, suggesting that a simple algorithm and formula can be used on available data to yield estimates of "cross-categorical citation."

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Georgia Institute of Technology/Daryl E. Chubin, Alan L. Porter, Fredrick A. Rossini, and Terry Connolly.

Availability:

Indicators of Interdisciplinary Research is available for inspection in SRS/Science Indicators Unit.

PROJECT:
Soviet R&D Statistics

Objective:

To provide updated statistics on R&D investments with particular attention paid to R&D science and engineering personnel in the Soviet Union.

Method:

Official Soviet data are analyzed at a disaggregated level and made compatible with U.S. data. Soviet S/E personnel data are adjusted to conform to the NSF concept of scientists and engineers employed in research and development. High and low estimates of the numbers of Soviet R&D scientists and engineers are provided.

Major Findings:

Soviet R&D investments rose through the late seventies and were considerably larger than U.S. investments—both in absolute numbers and in terms of the size of the economy. In 1982 the Soviet Union expended 24 billion rubles on research and development. This represented 3.65% of their gross national product. Attempts were made to present Soviet S/E personnel data in accordance with U.S. definitions. There were between 1.3 and 1.5 million Soviet scientists and engineers engaged in research and development in 1982. The concentration of R&D scientists and engineers in the labor force was the highest of any country: 9-10 R&D scientists and engineers for every 1,000 persons in the labor force in 1982.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Indiana University/Robert W. Campbell

Availability:

Robert W. Campbell, *Soviet R&D Statistics, 1975-1982*, National Science Foundation, 1983, available from SRS/

Editorial and Inquiries Unit. Previous reports by Robert Campbell also have useful information and data. See *Soviet R&D Statistics, 1977-1980*, NSF 80SP0727; National Technical Information Service, Springfield, Virginia 22161, PB 82-207408, $7.50 (paper copy), $4.00 (microfiche) and *Reference Source on Soviet R&D Statistics, 1950-78*, also available from SRS/Editorial and Inquiries Unit.

PROJECT:
Structure of Stock-Flow Relationships

Objective:

To develop a conceptual model that describes interrelationships among existing time series on resources for, and outputs for, science and technology.

Method:

Various statistical tools were used to examine relationships among time series identified. Analyses were devised in order to account for stocks and flows, time lags, and similar phenomenon.

Major Findings:

The project concluded that data on science and engineering education were positively related to scientific personnel data and (to a lesser extent) to scientific and technical literature indicators. Industrial R&D expenditures were positively linked with the utilization of resulting technologies. No linkage could be established between R&D expenditures and patents.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

National Planning Association/Nestor Terleckyj

Availability:

Final report is expected in fall 1983.

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